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IS 14494 (1998): Elastomer insultated flexible cables for use in mines (combined revision of IS:691 and IS:1026) [ETD 9: Power Cables]

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Indian Standard

ELASTOMER INSULATED FLEXIBLE CABLES FOR USE IN MINES — SPECIFICATION

ICS 29.060.20 ; 73

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

August 1998

Price Group 11

Power Cables Sectional Committee, ETD 09

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Power Cables Sectional Committee had been approved by the Electrotechnical Division Council.

The requirements for flexible cables for mines were covered by IS 691 : 1984 'Specification for flexible trailing cables for use in coal mines (*first revision*)' and IS 1026 : 1984 'Specification for flexible trailing cables for use in quarries and metalliferous mines (*first revision*)'. These standards were revised in 1984 and certain types covered previously have been omitted as having little interest. In this standard the requirements of both these standards and also some requirements of IS 9968 (Part 2) : 1981 'Specification for elastomer insulated cables : Part 2 For working voltages from 3.3 kV up to and including 11 kV' have been combined and new additional types have been included to make it more comprehensive. Also use of 11 kV cables have been included as its use in certain mines have become quite prevalent. Internationally accepted term 'elastomer' has been used in place of rubber for the insulating material in the standard. Further, in this standard only hea resisting elastomeric insulation has been retained and the other elastomeric insulation for general service has been deleted. The *Indian Electricity Rules* include additional provisions concerning the use of cables in mines The user should satisfy himself that these rules; in particular rules for additional precautions to be adopted in mines, are complied with when using these cables.

In preparing this standard, assistance has been derived from the following publications:

BS 6708 Trailing cables for mining purposes

NCB 188 Flexible trailing cables for use with coal cutters and similar purposes

French Specification M82-373 Mining equipment flexible trailing cables

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ELASTOMER INSULATED FLEXIBLE CABLES FOR USE IN MINES — SPECIFICATION

SECTION 1 GENERAL

1 SCOPE

1.1 The standard covers the requirement of flexible cables for use in coal mines, quarries and other miscellaneous mines for the following voltage grades:

1.1, 3.3, 3.8/6.6 and 6.35/11 kV

NOTES

1 Cables of 1.1 kV and 3.3 kV grades are suitable for both earthed and unearthed systems.

2 Cables of 3.8/6.6 kV and 6.35/11 kV grades are suitable for earthed system.

3 Cables of 6.35/11 kV grade (earthed system) are suitable for use on 6.6/6.6 kV (unearthed) also.

4 The cables conforming to this standard may be operated continuously at a power frequency voltage 10 percent higher than the rated voltage.

5 Under Rule 54 of the *Indian Electricity Rules*, 1956, in case of high voltage, the permissible variation of declared voltage at the point of commencement of supply is $^{+6}_{-9}$ percent.

These cables are suitable for use where the combination of ambient temperature and temperature-rise due to load results in conductor temperature not exceeding 90°C under normal operation and 250°C under short-circuit conditions.

2 REFERENCES

2.1 The Indian Standards given in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.1 For the purpose of this standard, the following definitions, in addition to those given in IS 1885 (Part 32), shall apply.

3.2 Routine Tests

Tests made by the manufacturer on all finished cable lengths to demonstrate the integrity of the cable.

3.3 Type Tests

Tests required to be made before supply on a general commercial basis on a type of cable in order to demonstrate satisfactory performance characteristics to meet the intended application.

NOTE — These tests are of such a nature that after they have been made they need not be repeated unless changes are made in the cable materials or design which might change the performance characteristics.

3.4 Acceptance Tests

Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

3.5 Earthed System

An electric system which fulfils any of the following conditions:

a) Neutral-point or the mid-point connection is earthed in such a manner that, even under fault conditions, the maximum voltage that can occur between any conductor and the earth does not exceed 80 percent of the nominal system voltage;

b) The neutral-point or the mid-point connection is not earthed but a protective device is installed which automatically cuts out any part of the system which accidentally becomes earthed; or

c) In case of ac systems only, the neutral-point is earthed through an arc suppression coil with arrangement or isolation within 1 h of occurrence of the fault for the non-radial field cables and within 8 h for radial cables, provided that the total of such periods in a year does not exceed 125 h.

NOTE — It should be realized that in a system where an earth fault is not automatically and promptly isolated, the extra stresses on the insulation of cables during the earth fault reduce the life of the cables to a certain degree. If the system is expected to be operated fairly often with a permanent earth fault, it may be advisable to classify the system in a higher category.

3.6 Unearthed System

An electric system which does not fulfil the requirement of the earthed system (*see* **3.5**).

3.7 Protective Screen

The metallic part of the screen, which is intended to carry the earth fault current.

SECTION 2 MATERIALS

4 CONDUCTOR

4.1 The conductor shall be composed of annealed tinned copper wires complying with IS 8130.

5 INSULATION

5.1 Insulation shall be of elastomer compound conforming to Type IE 2 of IS 6380 for voltage grade up to and including 1.1 kV and Type IE 3 of IS 6380 for voltage grades 3.3, 6.6 and 11 kV.

6 SEMI-CONDUCTING COMPOUND

6.1 The semi-conducting compound shall be so formulated as to be suitable for, the operating temperature of the cable both during sustained operation and during short circuit and shall have no deleterious effect on the cable insulation.

7 TAPE

7.1 Proofed Tape

The proofed tape shall be closely woven textile without selvedge proofed with rubber.

7.2 Polyethylene Terephalate (PETP) or Polypropylene Base Tape

7.3 Any other suitable tape based on glass, textile composite or other synthetic material.

8 SCREEN

8.1 The screening shall consist of one or more of the following, as specified:

a) Non-metallic semi-conducting tape,

b) Non-metallic semi-conducting compound, and

c) Annealed tinned copper wires.

NOTE — The semi-conducting tape and semi-conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material.

9 CENTRE

9.1 The centre shall consist of elastomeric compound or fibrous material suitable for the operating temperature of the cable and shall have no deleterious effect on the components of the cable.

10 FILLERS

10.1 The fillers shall consist of jute or similar roving, rubber compounds (including regenerated and unvulcanized rubber) or polymeric compounds. The fillers, at the manufacturer's discretion, may form an integral part of the rubber sheath.

10.2 The filler materials shall be suitable for operating temperature of the cable and shall have no deleterious effect on the components of the cable.

11 CRADLE SEPARATOR

11.1 The cradle separator shall consist of elastomeric compound suitable for the operating temperature of cable and shall have no deleterious effects on the insulating material.

12 ARMOUR

12.1 Armour shall consist of strands of galvanized steel wires, individual wires conforming to IS 3975.

13 SHEATH

13.1 Inner Sheath

The inner sheath shall consist of elastomeric compound complying with the requirements of Type SE 3 of IS 6380. The semi-conducting inner sheath where permitted shall be as per 6.

13.2 Outer Sheath

The outer sheath shall be of elastomeric compound conforming to Type SE 4 of IS 6380.

14 REINFORCEMENT MATERIAL

14.1 Tape

Tapes shall be according to 7.1.

14.2 Cords / Yarns

Cords / yarns wherever used for reinforcement shall be of cotton or synthetic materials.

SECTION 3 CONSTRUCTION

15 CONDUCTOR

15.1 The conductor formation shall be according to flexibility class 5 of IS 8130.

15.2 Earthing and Pilot Conductor

The size of the earthing conductor and pilot conductor if any shall be as given in Table 1 (*see* page 15) except where otherwise specified. The earth conductor(s) may be bare or covered. Earthing conductor of either Type A or Type B shall be used as recommended in 24.1.

15.2.1 It is permissible to split up the earthing conductor into equal parts and to place them in the interstices.

15.3 Separator Tape

A suitable separator tape may be applied over the conductor at the discretion of the manufacturer.

16 CONDUCTOR SCREENING

16.1 All cables rated above 3.8/6.6 kV shall be provided with conductor screening. It shall be provided over the conductor by applying non-metallic semi-conducting tape or by extrusion of semi-conducting compound or a combination of the two. This is applicable to power cores only.

17 INSULATION

17.1 The conductor (with or without separator or screen wherever applicable) shall be provided with elastomeric insulation.

17.2 Thickness of Insulation

The average thickness of insulation shall be not less than the nominal value (t_i) specified in Table 2 (*see* page 16).

NOTE — Thickness of any separator or semi-conducting screening on the conductor shall not be included in the thickness of insulation.

17.3 Application of Insulation

The insulation shall be so applied that it fits closely on the conductor (with or without either separator or screen) but shall not adhere to it. The insulation, unless applied by extrusion, shall be applied in two or more layers and it is applicable to cables with a rated voltage up to 1 100 volts.

17.4 Tolerance on Thickness of Insulation

The smallest of measured values of thickness of insulation shall not fall below the specified nominal values (t_i) by more than 0.1 mm + 0.1 t_i.

17.5 At the discretion of the manufacturer a tape may be applied over insulation.

18 INSULATION SCREENING AND PROTECTIVE SCREEN

18.1 Insulation Screen

18.1.1 All cables rated above 3.8/6.6 kV shall be provided with insulation screening.

18.1.2 The insulation screening shall consist of a non-metallic semi-conducting part in combination with a metallic part. This is applicable to power cores only.

18.1.3 The non-metallic part shall be applied directly over the insulation of each core and shall consist of either a semi-conducting tape or extruded semi-conducting compound or a combination of both, or either material in combination with a semi-conducting coating.

18.1.4 The metallic part shall be non-magnetic and applied over the non-metallic part. The metallic part shall consist of either a braid or spiral of tinned annealed copper wires not exceeding 0.51 mm in diameter. This shall not preclude the use of cord or other similar material.

18.1.5 For cables subjected to repeated flexing in service (for example in reeling drums) it is permissible to apply insulation screen consisting of non-metallic semi-conducting extruded screening alone subject to the permission from appropriate authorities. In such cases the insulated screen shall meet the requirements of the test specified in Annex B.

18.2 Protective Screen

18.2.1 Protective screens can be over individual core or collective as required in 'Details of Construction' (*see* **24**).

18.2.2 The protective screens shall be applied either spirally or in the form of braid consisting of tinned annealed copper wires not exceeding 0.51 mm in diameter. This shall not preclude the use of cord or other similar material.

NOTES

1 An optional separator tape below the protective screens may be applied at the discretion of the manufacturer.

2 Selection of Spiral or Braided Screen shall be as agreed between the purchaser and the manufacturer.

18.2.3 Where individual metallic screens (insulation or protective) are used, the conductance of such screens shall be not less than 25 percent of the main conductor and the combined conductance of all such screens shall be not less than of 15 mm^2 copper conductor.

18.2.4 Where collective screens are used the conductance shall be not less than 50 percent of that of the main conductor but in any case not less than that of 15 mm^2 copper conductor.

19 CORE IDENTIFICATION

19.1 The identification of cores for various types of cables shall be as follows except where otherwise specified:

Voltage Grade kV	*Method of Identification*
1.1, 3.3 and 3.8/6.6	a) Different colouring of insulation, or b) Coloured strips/tapes or coloured yarn in composite braid applied on the cores, or c) By numerals (1, 2, 3, etc) either by applying numbered strips/tapes or by printing on the cores
6.35/11	a) Coloured strips/tapes or coloured yarn in composite braid applied on cores, or b) By numerals (1, 2 and 3) either by applying numbered strips/tapes or by printing on the cores

19.2 Colour Scheme for Cores

No. of Cores	*Power Cores*	*Earth Cores*	*Pilot Cores*
2	Red, Yellow	—	—
3	Red, Yellow	Green	—
3	Red, Yellow, Blue	—	—
4	Red, Yellow, Blue	Green	—
5	Red, Yellow, Blue	Green	Black

19.3 When numerals are used for identification, these shall appear at intervals of not greater than 150 mm.

20 LAYING UP OF CORES

20.1 The cores shall be laid up with right hand lay. The length of lay shall not exceed the following, except where otherwise specified:

Up to 25 mm^2	15 times pitch circle diameter
Above 25 mm^2	18 times pitch circle diameter

20.2 The cradle separator where specified, shall be so made that the minimum distance between adjacent cores shall be 1.0 mm for FTD 3 cables and 1.8 mm for other types of cables covered in this standard.

20.3 There shall be no undue restraint on the relative movements of cores when the cable is flexed.

20.4 The interstices may be filled with fillers to provide reasonable circularity of laid-up cores at the discretion of the manufacturer.

20.5 A suitable binder tape may be applied over laid-up cores at the discretion of the manufacturer.

21 INNER SHEATH

21.1 The laid-up cores shall be provided with an inner sheath where required, applied by extrusion in such a way that it fits closely and it shall be possible to remove it without damage to the insulation.

21.2 Thickness of Inner Sheath

The thickness of inner sheath at any point, shall be not less than the value given in Table 3A or Table 3B (*see* pages 16 and 17).

21.3 A tape may be applied over the inner sheath at the discretion of the manufacturer.

22 ARMOURING

22.1 Armour shall consist of requisite number of galvanized steel strands to give a reasonable close cover. Each strand shall be composed of seven wires of the nominal size given in Table 4 (*see* page 17). The armour shall be applied with a length of lay not more than six times its pitch circle diameter.

NOTE — A suitable binder tape may be applied over the armour at the discretion of the manufacturer.

22.2 Direction of lay of armour shall be left hand and that of individual strand shall be right hand.

22.3 The conductance of the armour shall be not less than 50 percent of that of the largest conductor contained in the cable. To satisfy this, substitution of some galvanized steel wires in armouring by tinned copper wires is permissible.

23 OUTER SHEATH

23.1 The outer sheath shall be applied by extrusion as required in 24.

23.2 Thickness of Outer Sheath

The average thickness of the sheath except where otherwise specified shall be not less than the specified nominal values (t_s) given in Table 3 A or Table 3B (*see* pages 16 and 17).

23.3 Tolerance on Thickness of Sheath

The smallest of the measured values of thickness of sheath shall not fall below the nominal value (t_s) by more than 0.2 mm + 0.2 t_s.

NOTES

1 For unarmoured and collective unscreened cables it is permissible to apply the non-metallic reinforcing materials in the form of either a tape or braid between the inner and outer sheaths.

2 For certain unarmoured and collective unscreened cables, it is permissible to apply the two sheaths in one operation. The thickness of such a sheath shall be the addition of inner and outer sheaths. The tolerance of such a sheath shall be as per the tolerance of outer sheath.

3 For pliable armoured cables, it is permissible to incorporate non-metallic reinforcement material in the outer sheath.

4 In case of two layers of sheath with non-metallic reinforcement in between (that is inner sheath, reinforcement and outer sheath or outer sheath with reinforcement), the total combined thickness of two layers of sheath with the reinforcement shall be measured which shall satisfy the sum of the thickness of inner and outer sheaths or the total thickness of outer sheath as the case may be. For satisfying the thickness requirement, the average thickness shall be the sum of those given in **21.2** and **23.2** and the minimum thickness shall be the sum of those given in **21.2** and **23.3** or the thickness itself given in **23.2** for average thickness and in **23.3** for the minimum thickness as the case may be for these two types of reinforced sheath respectively.

23.4 The colour of sheath shall be black or any other colour as agreed between the purchaser and the supplier.

NOTE — A longitudinal mark of contrasting colour may be provided on the outer sheath to identify any twist in the cable as per specific agreement between the purchaser and the supplier.

24 DETAILS OF CONSTRUCTION

24.1 Constructional details of various types of cables shall be as detailed below:

Cable Type	*Voltage Grade* kV	*Power Core Size (Range)* mm²	*No. of Cores*	*Brief Construction*	*Sectional Diagram* (see *Annex*)	*Application* (see *Annex*)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
FT1	1.1	25 to 120	3	Three metallic screened power cores laid around centre, inner sheathed, pliable wire armoured and outer sheathed. The braided screen when provided shall incorporate non-metallic reinforcing material.	C	D
FT2	1.1	25 to 120	4	Three metallic screened power cores and one unscreened elastomeric covered earth core (Type A) laid around centre, inner sheathed, pliable wire armoured and outer sheathed. The earth core shall be built up to nominal diameter of power core. The braided screen when provided shall incorporate non-metallic reinforcing material.	C	D
FT3	1.1	16 to 95	5	Three power core, one earth core (Type B) and one pilot core (built up to diameter of power core) laid around cradle separator, inner	C	D

Cable Type	*Voltage Grade* kV	*Power Core Size (Range)* mm²	*No. of Cores*	*Brief Construction*	*Sectional Diagram* (see *Annex*)	*Application* (see *Annex*)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
				sheathed, protective metallic screened and outer sheathed.		
FT4(S)	1.1	16 to 95	5	Three metallic screened power core and one unscreened pilot core built up to diameter of power core laid around a bare earth conductor (Type A) and sheathed (combined inner- and outer sheath thickness). The braided screen when provided shall incorporate non-metallic reinforcing material.	C	D
FT6(S)	1.1	16 to 95	5	Three metallic screened power cores, one unscreened pilot core and one unscreened earth core (Type B) laid around centre and sheathed (combined inner and outer sheath thickness). The pilot and earth cores shall be built up to the nominal diameter of power core. The braided screen when provided shall incorporate non-metallic reinforcing material.	C	D
FT7	1.1	16 to 95	5	Three power cores and one pilot core having the same nominal cross sectional area each having metallic screen (braided screen when provided shall incorporate non-metallic reinforcing material) laid around bare earth conductor (Type A) and sheathed (combined inner and outer sheath thickness).	C	D
FT7(S)	1.1	25 to 120	7	Three metallic screened power cores and one unscreened elastomeric sheathed pilot unit containing three pilot cores, laid around bare earth conductor (Type A) and sheathed (combined inner and outer sheath thickness). The braided screen when provided shall incorporate non-metallic reinforcing material.	C	D

<table>
<tr><th><i>Cable Type</i></th><th><i>Voltage Grade</i> kV</th><th><i>Power Core Size (Range)</i> mm²</th><th><i>No. of Cores</i></th><th><i>Brief Construction</i></th><th><i>Sectional Diagram</i> (see <i>Annex</i>)</th><th><i>Application</i> (see <i>Annex</i>)</th></tr>
<tr><td>(1)</td><td>(2)</td><td>(3)</td><td>(4)</td><td>(5)</td><td>(6)</td><td>(7)</td></tr>
<tr><td></td><td></td><td></td><td></td><td>The pilot conductor size shall be as under:
<table>
<tr><th><i>Power Conductor Size</i> mm²</th><th><i>Pilot Conductor Size</i> mm²</th></tr>
<tr><td>25</td><td>2.5</td></tr>
<tr><td>35</td><td>2.5</td></tr>
<tr><td>50</td><td>4</td></tr>
<tr><td>70</td><td>6</td></tr>
<tr><td>95</td><td>6</td></tr>
<tr><td>120</td><td>10</td></tr>
</table>
The elastomeric sheathing compound of pilot unit shall be as per 13.1 and the sheathed pilot unit should have same nominal diameter as that of screened power core. For identification of pilot cores numerals 1, 2 and 3 shall be provided [<i>see</i> 19.1 (c)]. At the discretion of the manufacturer, fillers and/or tape may be applied in the pilot unit below sheath.</td><td></td><td></td></tr>
<tr><td>FT8</td><td>1.1</td><td>25 to 95</td><td>6</td><td>Three metallic screened power cores, one unscreened pilot core and two elastomeric covered or semiconducting compound covered earth conductors. The power cores laid around centre with the pilot core and covered earth conductors in three outer interstices and sheathed (combined inner and outer sheath thickness). The braided screen when provided shall incorporate non-metallic reinforcing material. The size of pilot and earth conductors shall be as under:
<table>
<tr><th><i>Power Conductor Size</i> mm²</th><th><i>Pilot and Earth Conductor Size</i> mm²</th></tr>
<tr><td>25</td><td>10</td></tr>
<tr><td>35</td><td>10</td></tr>
<tr><td>50</td><td>16</td></tr>
<tr><td>70</td><td>25</td></tr>
<tr><td>95</td><td>35</td></tr>
</table>
Both the covered earth conductors shall be identified by any method given in 19.</td><td>C</td><td>D</td></tr>
</table>

Cable Type	*Voltage Grade* kV	*Power Core Size (Range)* mm^2	*No. of Cores*	*Brief Construction*	*Sectional Diagram* (see *Annex*)	*Application* (see *Annex*)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
FT10	1.1	25 to 95	5	Three power cores and one pilot core each individually screened with semi-conductive elastomeric compound, laid around a semi-conductive elastomeric cradle separator containing a bare earth conductor (Type A) and sheathed (combined inner and outer sheathed thickness).	C	D
FTD3	1.1	6	5	Three power cores, an earth core and a pilot core are laid around an elastomeric cradle separator with length of lay not exceeding 10 times pitch circle diameter and outer sheath with nominal thickness (t_s) of 3.0 mm and nominal insulation thickness shall be 0.9 mm.	C	D
FTD3(S)	1.1	6	5	Three power cores, an earth core and a pilot core are laid around a semi-conducting cradle separator with length of lay not exceeding 10 times pitch circle diameter, inner sheathed with extruded semi-conducting compound having nominal thickness of 1.5 mm and outer sheathed with elastomeric compound with nominal thickness (t_s) of 2.5 mm.	C	D

NOTE — The use of these two types of Drill Cables FTD3 and FTD3(S) is restricted up to voltages not exceeding 250 V (ac).

Cable Type	*Voltage Grade* kV	*Power Core Size (Range)* mm^2	*No. of Cores*	*Brief Construction*	*Sectional Diagram* (see *Annex*)	*Application* (see *Annex*)
P3	1.1	6 to 95	5	Three power cores one earth core (Type B) and one pilot core (built up to power core diameter) laid around an elastomeric cradle separator, inner sheathed, pliable wire armoured and outer sheathed.	C	D
PLC2 PLC3 PLC4 PLC5	1.1	4	2, 3, 4 and 5	Two, three, four or five cores laid together, inner-sheathed, pliable wire armoured and outer sheathed.	C	D

NOTES

1 The use of these four types of cables is restricted up to 550 V (ac).

2 The numerals provided at the end of each type indicate the number of cores.

3 When core identification will be provided by colours, the scheme given in **19.2** shall be followed.

Cable Type	*Voltage Grade* kV	*Power Core Size (Range)* mm^2	*No. of Cores*	*Brief Construction*	*Sectional Diagram* (see *Annex*)	*Application* (see *Annex*)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
PA3	1.1	6 to 185	3	Two power cores and one earth core (Type B) laid around an elastomeric cradle separator, inner sheathed, pliable wire armoured and outer sheathed. The earth core shall be built upto nominal diameter of power core.	C	D
PA1	1.1	6 to 185	4	Same as Type PA3 but three power cores and one earth core (Type B)	C	D
3PA1	3.3	16 to 185	4	do	C	D
6PA1	3.8/6.6	16 to 185	4	do	C	D
3FTS	3.3	16 to 185	4	Three power cores individually metallic screened and one unscreened earth core (Type B) laid around centre, inner sheathed, optional reinforcement and outer sheathed. The braided screen when provided shall incorporate non-metallic reinforcing material. When non-metallic reinforcement in between inner and outer sheaths is not provided, then unsheath with combined inner and outer sheath thickness is permitted.	C	D
6FTS	3.8/6.6	16 to 185	4	do	C	D
3FTCS	3.3	16 to 185	4	Three insulated power cores and one semi-conducting compound covered earth conductor (Type B) laid around a semiconductive elastomeric centre, inner sheathed with semiconductive elastomeric compound, optional semiconductive taped, collectively metallic screened and outer sheathed. Whenever strip tape is used to identify the semiconducting compound covered earth conductor, it shall be applied with suitable gap so that the electrical continuity of semiconducting layer over earth conductor with semiconducting inner sheath is maintained.	C	D
6FTCS	3.8/6.6	16 to 185	4	Same as mentioned in Type 3FTCS	C	D
3FTINS	3.3	16 to 185	4	Three power cores individually screened with semiconductive elastomeric compound and earth conduc-	C	D

Cable Type	*Voltage Grade* kV	*Power Core Size (Range)* mm^2	*No. of Cores*	*Brief Construction*	*Sectional Diagram* (see *Annex*)	*Application* (see *Annex*)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
				tor (Type B) covered with semi-conducting elastomeric compound laid around a semi-conducting elastomeric centre, inner sheathed, non-metallic reinforcement and outer-sheathed. Whenever strip/tape is used to identify the power cores and earth conductor, it shall be applied with suitable gap so that the electrical continuity of semi-conducting layer of power cores and earth conductor is maintained.		
6FTINS	3.8/6.6	16 to 185	4	do	C	D
11FTINS	6.35/11	25 to 185	4	do	C	D
3FTINS/3	3.3	16 to 185	6	Same as 3FTINS, but earth core splitted into three. Three power cores are laid with three earth cores in three outer interstices. All the three earth cores shall have same colour or number for core identification. Whenever strip/tape is used to identify the power cores and earth cores, it shall be applied with suitable gap so that the electrical continuity of semiconducting layer of power cores and earth cores is maintained.	C	D
6FTINS/3	3.8/6.6	16 to 185	6	Same as in Type 3FTINS/3	C	D
11FTINS/3	6.35/11	25 to 185	6	do	C	D
11LL	6.35/11	25 to 185	4	Three power cores individually metallic screened and earth core (Type A) with elastomeric covering or with semiconducting compound covering, laid up around centre, inner sheathed, non-metallic reinforcement and outer sheathed. Whenever strip/tape is used to identify the power cores and earth core over conducting/semi-conducting layer, it shall be applied with suitable gap so that the electrical continuity of conducting/semi-conducting layers of power cores and earth core is maintained.	C	D

Cable Type	*Voltage Grade* kV	*Power Core Size (Range)* mm²	*No. of Cores*	*Brief Construction*	*Sectional Diagram* (see *Annex*)	*Application* (see *Annex*)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
11LL/3	6.35/11	25 to 185	6	Three power cores individually metallic screened and earth core (Type A) with elastomeric covering or with semiconducting compound covering, laid up around centre, inner sheathed, non-metallic reinforcement and outer sheathed. Whenever strip/tape is used to identify the power cores and earth core over conducting/semi-conducting layer, it shall be applied with suitable gap so that the electrical continuity of conducting/semi-conducting layers of power cores and earth core is maintained but earth core splitted into three. Three power cores are laid with three earth cores in three outer interstices. All the three earth cores in three outer interstices. All the three earth cores shall have same colour or number for core identification. Whenever strip/tape is used to identify the power cores and earth cores over conducting/semiconducting layer, it shall be applied with suitable gap so that the electrical continuity of conducting/semi-conducting layers of power cores and earth cores is maintained.	C	D
3PA1(S)	3.3	16 to 120	4	Three metallic screened power cores and one un-screened elastomeric covered earth core (Type A) laid around centre, inner sheathed, pliable wire armoured and outer sheathed. The earth core shall be built up to nominal diameter of power core. The braided screen when provided shall incorporate non-metallic reinforcing material.	C	D
6PA1(S)	3.8/6.6	16 to 120	4	do	C	D

24.2 Overall Diameters

The overall diameters shall not exceed the maximum limit specified in respective tables (*see* Tables 5 to 18 appearing on page 18 to 22)

24.3 The fictitious calculation method for determination of dimensions of protective coverings of cables shall be as per Annex E.

SECTION 4 TESTS

25 CLASSIFICATION OF TESTS

25.1 Type Tests

The following shall constitute type tests:

Test (1)	*For Requirements* see *IS and Clause No. of this Standard/Tables* (2)	*For Test Method,* see *Part of IS 10810* (3)
a) *Tests on Conductor*		
i) Annealing Test	8130	1
ii) Conductor Resistance Test	8130	5
b) *Tests for Armouring Wires*		
i) Dimensions	3975	36
ii) Tensile Strength and elongation at break	3975	37
iii) Torsion (for round wires only)	3975	38
iv) Zinc coating	3975	40 and 41
v) Conductance	22.3	42
c) *Test for Thickness of Insulation and Sheath*	17, 21, 23 and Tables 2 and 3	6
d) *Physical Tests on Insulation and Sheath (as Applicable)*		
i) Tensile strength and elongation at break	6380	7
ii) Ageing in air oven	do	11
iii) Ageing in air bomb	do	56
iv) Hot set test	do	30
v) Oil resistance test	do	31
vi) Tear resistance test	do	17
vii) Ozone resistance test	do	13
e) *Insulation Resistance (Insulation Resistance Constant Test)*	do	43
f) *Partial Discharge Test*	26.2	46
g) *Bending Test followed by Partial Discharge Test*	26.3	50
h) *Dielectric Power Factor Test* i) As a function of voltage ii) As a function of temperature	26.4	48
j) *Heating Cycle Test followed by Partial Discharge Test*	26.5	49
k) *High Voltage Test*	26.6	45
m) *Water Absorption Test*	6380 and 26.8	28
n) *Flammability*	26.7	53
p) *Electrical Test on Semi-conducting Non-metallic Core Screen Where Provided in Place of Metallic Core Screen on Power Cores*	Annex B	Annex B

25.1.1 Tests (f), (g), (h) and (j) are applicable to screened cables, that is, cables with rated voltage above 3.8/6.6 kV.

25.1.2 For 11 kV cables, the following electrical type tests shall be performed successively on the same sample of completed cable not less than 10 m in length between test accessories except for tests at (a), (d), (e) and (f) which may be carried out on different samples.

a) Insulation resistance at room temperature (Insulation resistance constant test);

b) Partial discharge test;

c) Bending test followed by partial discharge test;

d) Dielectric power factor as a function of voltage;

e) Dielectric power factor as a function of temperature;

f) Insulation resistance (Insulation resistance constant test) at maximum continuous operating temperature;

g) Heating cycle test followed by partial discharge test; and

h) High voltage test.

25.1.2.1 If the sample fails in test h), a new sample may be taken for this test, preceded by tests c) and g).

25.2 Acceptance Tests

The following shall constitute the acceptance tests:

a) Annealing test;

b) Conductor resistance test;

c) Test for thickness of insulation and sheath;

d) Tensile strength and elongation at break test of insulation and sheath;

e) Hot set test for elastomeric insulation and sheath;

f) Partial discharge test (for 11 kV cables only);

g) High voltage test; and

h) Electrical test on semiconducting non-metallic core screen where provided in place of metallic core screen on power cores (*see* Annex B).

25.2.1 A recommended sampling plan for acceptance tests is given in Annex F.

25.3 Routine Tests

The following shall constitute the routine tests and shall be carried out on full drum lengths of completed cables:

a) Conductor resistance test;

b) Partial discharge test (for 11 kV cables only); and

c) High voltage test.

NOTES

1 Out of various tests (*see* **25.1**, **25.2** and **25.3**), only conductor resistance test shall be applicable for earth conductor(s)/core(s).

2 Out of various tests (*see* **25.1**, **25.2** and **25.3**), only conductor resistance test and high voltage test shall be applicable for pilot core(s).

26 DETAILS OF TESTS

26.1 General

Unless otherwise stated in this standard, the test shall be carried out in accordance with appropriate part of IS 10810 taking into account additional requirements given in this standard.

26.2 Partial Discharge Test

The partial discharge magnitude at test voltage equal to 1.5 Q_{uo} shall not exceed 20 pC.

26.3 Bending Test

The diameter of test cylinder shall be $8D \pm 5$ percent where D is the overall diameter of the completed cable. After bending operations, the test sample shall be subjected to partial discharge measurements and shall comply with the requirement given in **26.2**.

26.4 Dielectric Power Factor Test

26.4.1 *Tan δ as Function of Voltage*

The measured value of tan δ at U_0 shall not exceed 0.02 and the increment of tan δ between 0.5 U_0 and 2 U_0 shall not be more than 0.002 5.

26.4.2 *Tan δ as Function of Temperature*

The measured value of tan δ shall not exceed 0.02 at ambient temperature and 0.04 at 90°C.

26.5 Heating Cycle Test

The sample which has been subjected to previous tests, shall be laid out on the floor of the test room and subjected to heat cycles. After third cycle, the sample shall be subjected to partial discharge measurements and shall comply with the requirement given in **26.2**.

26.6 High Voltage Test

26.6.1 *Type/Acceptance Tests*

26.6.1.1 *For* 1.1 *kV grade cables*

26.6.1.1.1 *Type test (water immersion test)*

The power/pilot core(s) shall be carefully removed from a sample approximately 3 meters long, taken from the finished cable. They shall be so immersed in a water bath at room temperature that their ends protrude at least 200 mm above the water level. After 24 hours, an ac voltage of 3 kV (rms) shall be applied between conductor and water. This voltage shall be raised to 6 kV (rms) within 10 seconds and held constant at this value for 5 minutes. If the sample fails in this test, one more sample shall be subjected to this test which shall pass.

26.6.1.1.2 *Acceptance test*

This shall be same as routine test

26.6.1.2 *For* 3.3 *kV and above grade cables*

The type /acceptance tests shall be four hours test. The cables shall withstand without breakdown, an ac voltage equal to 3 U_0 when applied to the sample between conductor and screen / armour (and between conductors in case of unscreened cables). The voltage shall be gradually increased to the specified value and maintained for four hours. This test is applicable to power cores only.

26.6.2 *Routine Test*

The cable shall withstand, without breakdown a power frequency ac voltage as specified below in the table. The voltage shall be applied and increased gradually to the full value and maintained for five minutes. The test shall be carried out at room temperature:

Voltage Grade of Cable kV	*ac Test Voltage,* kV *(For Power Cores)*	
	Between Conductor and Armour / Screen	Between Conductors[1]
(1)	(2)	(3)
1.1	3	3
3.3	10	10
3.3/6.6	12	20
6.35/11	17	—

NOTE — For pilot core(s), the test voltage shall be 3 kV ac which shall be applied between conductors/conductor and screen as the case may be for five minutes.

[1] Not applicable for cables with screened cores.

26.7 Flammability Test

Period of burning after removal of the flame shall not exceed 60 seconds and the unaffected portion from the lower edge of the top clamp shall be at least 50 mm.

26.8 Water Absorption Test

This test shall not be made on cables that have a non-conductive separator between the conductor and insulation, insulation less than 1.2 mm thick, and insulation having a covering that cannot be removed without damage to the insulation. The test samples of the insulated conductors shall be taken after vulcanization and prior to the application of any covering except that which may have been applied before vulcanization. Such coverings shall be removed before the test is made.

SECTION 5 IDENTIFICATION, PACKING AND MARKING

27 IDENTIFICATION

27.1 Manufacturer's Identification

The manufacturers shall be identified throughout the length of the cable by means of a tape, bearing the manufacturer's name or trade-mark or by manufacturer's name or trade-mark being printed, indented or embossed on the outer sheath. In case none of these methods can be employed or if so desired by the purchaser, coloured identification threads in accordance with a scheme to be approved by the Bureau of Indian Standards shall be employed.

27.2 Voltage Identification

The voltage grade of the cable shall be identified throughout the length of the cable by means of a tape bearing the voltage grade of the cable (for example 1.1 kV, 3.3 kV, 3.8/6.6 kV and 6.35/11 kV) or by the voltage grade being printed, embossed or indented on outer sheath.

27.3 Type of Cable

The cable type, using the appropriate designation as given in **24.1** shall also be marked throughout the length of cable by any of the means indicated above.

NOTE — Single tape, giving information required in **27.1** to **27.3** is also permissible.

28 PACKING AND MARKING

28.1 The cable shall be wound on a drum (*see* IS 10418).

28.2 The cut ends of the cable shall be sealed by means of non-hygroscopic sealing material.

28.3 The cable shall carry the following information either stenciled on the drum or contained in a label attached to it:

a) Reference to this Indian Standard;
b) Manufacturer's name, brand name or trade-mark;
c) Type of cable and voltage grade;
d) Number of cores;
e) Nominal cross-sectional area of the conductor;
f) Cable type;
g) Length of cable on the drum;
h) Number of lengths on drum (if more than one);
j) Direction of rotation of drum (by means of an arrow);
k) Approximate gross mass;
m) Country of manufacture; and
n) Year of manufacture.

28.3.1 *Standard Marking*

The cable (drum or label) may also be marked with the Standard Mark.

28.3.1.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

SECTION 6 TABLES

Table 1 Size of Power, Earthing and Pilot Conductors Except Where Otherwise Specified in Clause 24

(*Clause* 15.2)

Power Conductor mm² (1)	Earthing Conductor Type-A mm² (2)	Earthing Conductor Type-B mm² (3)	Pilot Conductor mm² (4)
2.5	2.5	2.5	2.5
4	4	4	4
6	6	6	6
10	10	10	10
16	16	16	16
25	16	25	16
35	16	35	16
50	25	50	25
70	35	70	35
95	50	95	50
120	70	120	70
150	70	150	70
185	95	185	95
240[1]	120	240	120
300[1]	150	300	150

[1] For future requirements.

Table 2 Insulation Thickness

(*Clauses* 17.2 *and* 25)

Nominal Area of Conductor	Nominal Thickness of Insulation (t_i) for Power Cores			
	1.1 kV	3.3 kV	3.8/6.6 kV	6.35/11 kV
mm²	mm	mm	mm	mm
(1)	(2)	(3)	(4)	(5)
2.5	1.0	—	—	—
4	1.0	—	—	—
6	1.0	—	—	—
10	1.2	—	—	—
16	1.2	2.2	3.0	—
25	1.4	2.2	3.0	4.0
35	1.4	2.2	3.0	4.0
50	1.6	2.2	3.0	4.0
70	1.6	2.2	3.0	4.0
95	1.8	2.4	3.0	4.0
120	1.8	2.4	3.0	4.0
150	2.0	2.4	3.0	4.0
185	2.2	2.4	3.0	4.0
240[1)]	2.4	2.4	3.0	4.0
300[1)]	2.6	2.6	3.0	4.0

NOTES

1 The nominal thickness of insulation (t_i) for pilot core(s) shall be 1.0 mm. However, higher thickness whenever required to build up the diameter is permitted.

2 The thickness of covering on earth conductor(s) shall be suitably selected for covered earth conductor(s).

[1)] For future requirements.

Table 3A Thickness of Inner and Outer Sheath Except Where Otherwise Specified (Except for Collective Metallic Screened and Pliable Wire Armoured Cables)

(*Clauses* 21.2, 23.2 23.3, 25 *and* E-2.4)

Calculated Diameter Under Inner Sheath (*see* Annex E)		Minimum Thickness of Inner Sheath	Nominal Thickness of Outer Sheath (t_s)
Over	Up to and Including		
mm	mm	mm	mm
(1)	(2)	(3)	(4)
—	10	1.4	2.0
10	15	1.6	2.4
15	20	1.8	2.6
20	25	2.0	2.8
25	30	2.2	3.0
30	40	2.4	3.2
40	50	2.8	3.6
50	60	3.2	4.0
60	70	3.6	4.5
70	80	4.0	5.0
80	—	4.4	5.5

Table 3B Thickness of Inner and Outer Sheath Except Where Otherwise Specified (for Collective Metallic Screened and Pliable Wire Armoured Cables)

(*Clauses* 21.2, 23.2, 23.3, E-2.4 *and* E-2.7)

Calculated Diameter Under Inner Sheath for Choosing Thickness of Inner Sheath and Calculated Dia Under Outer Sheath for Choosing Thickness of Outer Sheath (*see* Annex E)		Minimum Thickness of Inner Sheath	Nominal Thickness of Outer Sheath (t_s)
Over mm	Up to and including mm	mm	mm
(1)	(2)	(3)	(4)
—	10	1.6	2.5
10	15	1.8	2.8
15	20	2.0	3.2
20	25	2.2	3.6
25	30	2.4	4.0
30	40	2.6	4.5
40	50	3.0	5.0
50	60	3.5	5.7
60	70	4.0	6.4
70	80	4.5	7.1
80	90	5.0	7.8
90	100	5.5	8.5
100	—	6.0	9.0

Table 4 Dimensions of Pliable Wire Armour

(*Clause* 22.1)

Calculated Diameter Under Armour (*see* Annex E)		Size of Armour Strand
Above mm	Up to and Including mm	Number/mm
(1)	(2)	(3)
—	25	7/0.45
25	40	7/0.70
40	60	7/0.90
60	—	7/1.25

Table 5 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters	
	Type FT1	Type FT2
mm²	mm	mm
(1)	(2)	(3)
25	54.0	59.5
35	59.0	63.0
50	66.5	72.5
70	73.5	79.0
95	81.0	90.0
120	86.0	96.0

Table 6 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters	
	Type FT3	Type FT4(S)
mm²	mm	mm
(1)	(2)	(3)
16	51.0	47.5
25	56.5	48.5
35	62.0	52.0
50	69.5	58.5
70	78.0	67.0
95	89.0	79.5

Table 7 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters	
	Type FT6(S)	Type FT7
mm²	mm	mm
(1)	(2)	(3)
16	47.0	47.5
25	53.0	48.5
35	57.0	52.0
50	66.5	58.5
70	74.0	67.0
95	83.5	79.5

Table 8 Maximum Overall Diameters
(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters	
	Type FT7(S)	Type FT8
mm²	mm	mm
(1)	(2)	(3)
25	49.5	48.0
35	53.0	49.0
50	59.5	56.0
70	68.0	67.0
95	80.5	74.0
120	93.0	—

Table 9 Maximum Overall Diameters
(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters Type FT10
mm²	mm
(1)	(2)
25	52.0
35	57.5
50	66.0
70	72.0
95	81.5

Table 10 Maximum Overall Diameters
(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters	
	Type FTD 3	Type FTD3(S)
mm²	mm	mm
(1)	(2)	(3)
6	25.5	32.5

Table 11 Maximum Overall Diameters
(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters Type P3
mm²	mm
(1)	(2)
6	42.0
10	49.5
16	53.5
25	59.0
35	64.5
50	73.0
70	80.0
95	90.0

Table 12 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size mm²	Maximum Overall Diameters PLC2 mm	 PLC3 mm	 PLC4 mm	 PLC5 mm
(1)	(2)	(3)	(4)	(5)
4	30.0	31.0	32.5	34.0

Table 13 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size mm²	Maximum Overall Diameters Type PA1 mm	 Type PA3 mm
(1)	(2)	(3)
6	39.5	36.5
10	43.5	40.0
16	50.5	44.0
25	55.5	51.5
35	59.0	55.0
50	67.5	61.5
70	75.0	67.5
95	81.5	75.5
120	87.0	79.0
150	98.0	86.0
185	105.5	95.0

Table 14 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size mm²	Maximum Overall Diameters Type 3PA1 mm	 Type 6PA1 mm
(1)	(2)	(3)
16	57.0	63.0
25	61.0	66.5
35	65.0	71.0
50	71.0	78.0
70	78.5	83.0
95	86.0	91.0
120	91.0	99.0
150	100.0	105.0
185	106.9	111.5

Table 15 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters	
	Type 3FTS	Type 6FTS
mm²	mm	mm
(1)	(2)	(3)
16	51.0	55.5
25	54.5	58.5
35	57.5	63.5
50	65.0	69.5
70	70.0	77.0
95	80.5	84.0
120	84.0	90.0
150	92.5	96.0
185	97.5	103.5

Table 16 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters		
	Type 3FTCS	Type 6FTCS	Type 3FTINS
mm²	mm	mm	mm
(1)	(2)	(3)	(4)
16	50.5	55.5	51.5
25	54.5	59.5	55.0
35	58.5	64.0	58.5
50	65.5	69.5	66.5
70	71.5	77.0	71.5
95	80.0	83.5	81.0
120	86.5	90.0	86.0
150	91.5	95.0	93.0
185	97.5	104.0	98.0

Table 17 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters				
	Type 6FTINS	Type 11FTINS	Type 3FTINS/3	Type 6FTINS/3	Type 11FTINS/3
mm²	mm	mm	mm	mm	mm
(1)	(2)	(3)	(4)	(5)	(6)
16	56.0	—	47.0	52.0	—
25	59.5	62.0	51.0	55.0	66.5
35	65.0	77.5	54.0	58.0	69.0
50	71.0	84.0	59.5	65.5	75.0
70	78.0	91.0	66.0	70.0	81.5
95	84.0	97.0	72.5	77.5	87.0
120	91.5	102.5	79.0	82.0	94.0
150	96.5	109.5	83.5	86.5	98.5
185	104.0	114.5	88.0	93.0	105.0

Table 18 Maximum Overall Diameters

(*Clause* 24.2)

Power Core Size	Maximum Overall Diameters			
	11LL	11LL/3	3 PA1(S)	6 PA1(S)
mm^2	mm	mm	mm	mm
(1)	(2)	(3)	(4)	(5)
16	—	—	61.5	67.0
25	78.5	70.5	66.0	70.5
35	82.0	73.5	69.5	76.5
50	88.0	81.0	78.0	82.0
70	95.0	85.5	83.0	90.0
95	102.0	94.0	96.0	101.0
120	108.0	97.0	102.0	107.0
150	114.5	103.0	—	—
185	122.0	109.5	—	—

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
2 : 1960	Rules for rounding off numerical values (*revised*)
1885 (Part 32) : 1993/ IEC 50 (461) : 1984	Electrotechnical vocabulary : Part 32 Electric cables (*first revision*)
3975 : 1988	Mild steel wires, formed wires and tapes for armouring of cables (*first revision*)
4905 : 1968	Methods for random sampling
6380 : 1984	Elastomeric insulation and sheath of electric cables (*first revision*)
8130 : 1984	Conductors for insulated electrical cables and flexible cords (*first revision*)
10418 : 1982	Drums for electric cables
10810	Methods of test for cables

ANNEX B

[*Clauses* 18.1.5, 25.1(n) *and* 25.2(h)]

ELECTRICAL TEST ON SEMI-CONDUCTING NON-METALLIC CORE SCREEN WHERE PROVIDED IN PLACE OF METALLIC CORE SCREEN ON POWER CORES

B-1 A sample of cable shall be taken at least 300 mm from the end of factory length and a test voltage of 70 V ac, 40 Hz to 60 Hz with a series resistance of 225 ohm connected to the test circuit, shall be applied between a power conductor and the earth conductor.

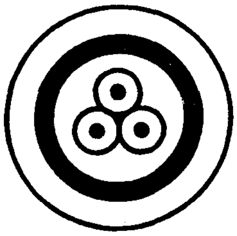
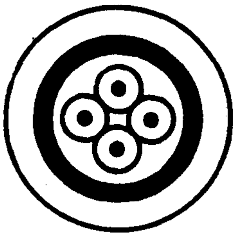
B-2 A fault shall be created by means of approximately 0.9 mm bare steel needle pushed through the outer sheath of the cable, through the conducting elastomeric screen and into the power conductor. The leakage current shall be recorded and shall reach a value of not less than 125 mA within 10 ms from the instant the needle makes contact with the power conductor and shall not fall below 125 mA within 200 ms from that instant. Alternatively, the needle may be inserted before the test voltage is applied in which case the time interval and current flow are determined from the instant the voltage is switched on.

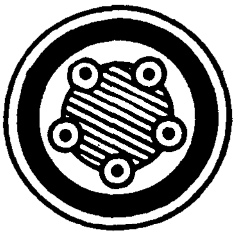
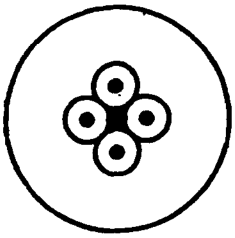
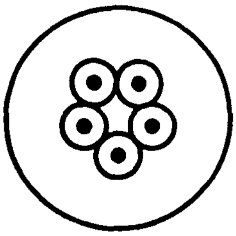
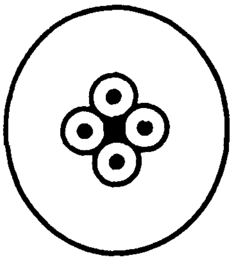
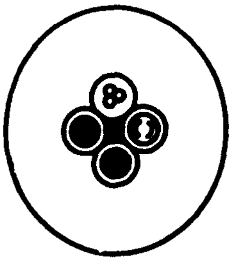
B-3 If the flow of current from any one core does not comply with the requirements specified under **B-2**, two further test on each of the three cores shall be carried out at approximately 150 mm and 300 mm respectively from the point of original measurement. If each of these additional tests produces a current flow that complies with the requirements of **B-2**, the cable shall be deemed to have satisfied the requirements.

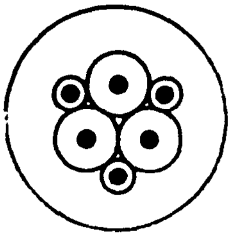
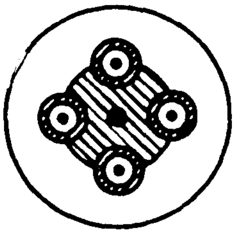
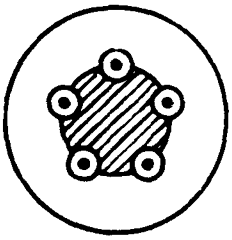
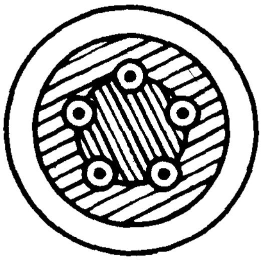
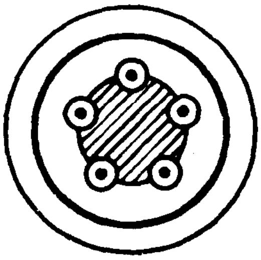
ANNEX C

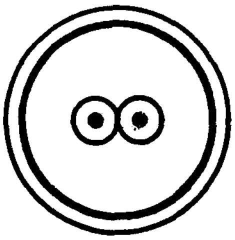
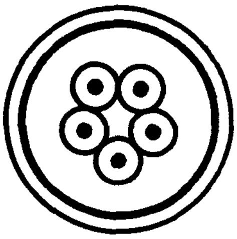
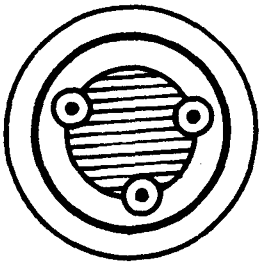
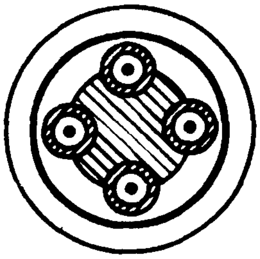
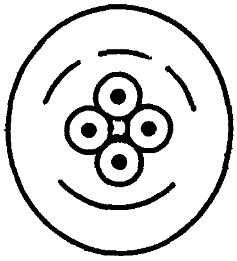
(*Clause* 24.1, *Sectional Diagram, col* 6)

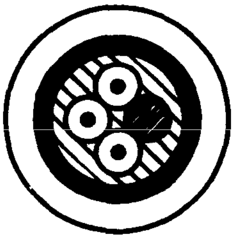
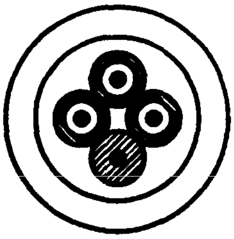
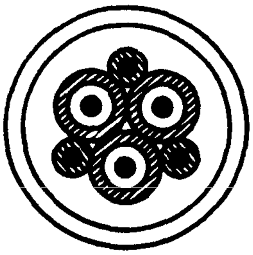
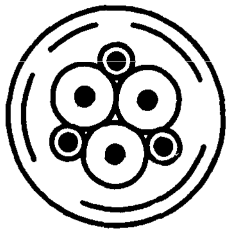
(For General Guidance Only)

Cable Type (1)	*Voltage Grade* (kV) (2)	*Sectional Diagram* (3)
FT1	1.1	
PLC3	do	
FT2	do	
PLC4	do	
3PAI(S)	3.3	
6PAI(S)	3.8/6.6	

Cable Type (1)	*Voltage Grade* (kV) (2)	*Sectional Diagram* (3)
FT3	1.1	
FT4(S)	1.1	
FT6(S)	1.1	
FT7	1.1	
FT7(S)	1.1	

Cable Type (1)	*Voltage Grade* (kV) (2)	*Sectional Diagram* (3)
FT 8	1.1	
FT 10	1.1	
FTD3	1.1	
FTD3(S)	1.1	
P3	1.1	

Cable Type (1)	*Voltage Grade* (kV) (2)	*Sectional Diagram* (3)
PLC2	1.1	
PLC5	1.1	
PA3	1.1	
PA1 3PA1 6PA1	1.1 3.3 3.8/6.6	
3FTS 6FTS 11LL	3.3 3.8/6.6 6.35/11	

Cable Type (1)	*Voltage Grade* (kV) (2)	*Sectional Diagram* (3)
3FTCS 6FTCS	3.3 3.8/6.6	
3FTINS 6FTINS 11FTINS	3.3 3.8/6.6 6.35/11	
3FTINS/3 6FTINS/3 11FTINS/3	3.3 3.8/6.6 6.35/11	
11LL/3	6.35/11	

ANNEX D

(*Clause* 24.1, *col* 7)

(For General Guidance Only)

FT1	Intrinsic safety cable in U/G production systems requiring infrequent movement — 3 phase.
FT2	Intrinsic safety cable in U/G production systems requiring infrequent movement — 3phase and earth.
FT3	Cable for mobile production machines in U/G applications.
FT4 (S)	Cable for production-cum-transportation machines in U/G application— Crawler mounted requiring medium degree of movement.
FT 6(S)	Cable for mobile production machines in U/G applications.
FT7	Heavy duty trailing cable for mobile production machines in U/G applications with multipurpose built-in attachments like intermediate crusher, steel-tray conveyor, etc, for example road headers.
FT7(S)	Heavy duty trailing cable for mobile production machines in U/G applications with remote control/annunciation requirements, for example, sophisticated road headers, shearers in multipurpose packages, etc, suitable for use as interconnecting cables also.
FT8	Heavy duty trailing cable for mobile production machines in U/G application and surface use material handling application to satisfy space limitation, for example, Augar-cum-drill, Paddle feeders, Stacker/Reclaimer, etc.
FT10	Trailing cable for wheel mounted production support machines calling for heavy reeling duty requirement in U/G mines, for example, LHD's, Low height SDL's, etc.
FTD3	Cable for hand-held drills.
FTD 3(S)	Cables for hand-held drills with intrinsic safety requirement.
P3	Power feeders to transportation/ ventilation system in U/G mines.
PLC2 to PLC5	Cable for lighting and auxiliary circuits in U/G application.
PA3	Cable for single phase/D.C. application.
PA1, 3PA1, 6PA1	Cable requiring infrequent movement in OCM Zone prew to cause external injury by thrust.
3PA1(S), 6PA1(S)	Cable with intrinsic safety system requiring protection against electrical as well as mechanical adverse elements, for example, application area of Jumbo SH drills, Walking dragline, OCM Power feeders in new excavation areas, etc.
3FTS, 6 FTS	OCM trailing cable for machines requiring medium degree of movement, for example, Excavators.
3FTCS, 6 FTCS	OCM trailing cable for reeling duty, for example, BH drills, Excavators with CRD.
3FTINS, 6FTINS, 11FTINS	Trailing cable for heavy reeling duty OCM and material handling applications requiring high terrible strength.
3FTINS/3, 6FTINS/3, 11FTINS/3	Trailing cable with space limitation in CRD, for example, BWE's, Stacker/ Reclaimers.
11LL, 11LL/3	Hazardous duty mine power feeder in OCM, for example, Landline.

ANNEX E

(*Clause* 24.3, *Tables* 3A, 3B *and* 4)

FICTITIOUS CALCULATION METHOD FOR DETERMINATION OF DIMENSIONS OF PROTECTIVE COVERINGS

E-1 GENERAL

E-1.1 This standard specifies some of the parameters such as, inner and outer sheath thickness and armour size on the basis of calculated cable diameters which are not necessarily be the same as actual values achieved in production. In borderline cases, queries can arise if any of these parameters does not correspond to the actual diameter because calculated diameter may be different.

E-1.2 To avoid variation in flexible conductor dimensions and method of calculation from manufacturer to manufacturer, the fictitious calculation method has been invented. The idea is to ignore the degree of variation of diameter of flexible conductors and to calculate fictitious diameters from the formulae based on the cross-sectional area of conductor, insulation thickness and number of cores. Various parameters which are independent of difference in manufacturing practices are then related to fictitious diameters by formulae or by tables. This method helps in standardizing cable designs, different parameters being pre-calculated and specified for each type and size of cable.

E-1.3 The fictitious calculation is used only to determine dimensions of sheaths and armour. It is not a replacement for the calculation of normal diameters required for practical purposes, which should be calculated separately.

E-1.4 The calculated value of fictitious diameter at each stage shall be rounded off to one significant place of decimal, that is 0.1 mm, before proceeding to next step. The rounding off shall be done in accordance with IS 2.

E-2 METHOD OF CALCULATION

E-2.1 The calculation is to be based on power/main core.

E-2.2 The fictitious diameter (d_L) of a conductor, irrespective of configuration of bunching, multiple stranding, is given for each nominal cross-section in Table 19.

E-2.3 The fictitious diameter, D_C of core is given by:

a) For unscreened cores : $D_C = D_L + 2\,t_i$ mm

b) For cables of rated voltage of 1.1 kV, 3.3 kV and 3.8/6.6 kV:

  i) For metallic screened cores:

$$D_C = d_L + 2\,t_i + 3.0\ \text{mm.}$$

  ii) For non-metallic that is semi conducting compound screened

Table 19 Fictitious Diameter of Conductor

(*Clause* E-2.2)

Nominal Cross-Sectional Area of Conductor mm² (1)	d_L mm (2)
2.5	2.0
4	2.6
6	3.6
10	4.6
16	5.7
25	7.1
35	8.5
50	10.3
70	12.4
95	14.5
120	16.0
150	18.0
185	20.0
240	23.0
300	26.0

cores:

$$D_C = d_L + 2\,t_i + 3.0\ \text{mm}.$$

c) For cables of rated voltage of 6.35/11 kV:

  i) For metallic screened cores:

$$D_C = d_L + 2\,t_i + 6.0\ \text{mm}.$$

  ii) For non-metallic, that is semiconducting compound screened cores:

$$D_C = d_L + 2\,t_i + 4.5\ \text{mm}.$$

where, t_i is the nominal thickness of insulation (in mm).

E-2.4 Diameter Over Laid Up Cores

The fictitious diameter over laid up cores, D_f shall be as given below:

a) For cables having all cores of the same fictitious diameter:

$$D_f = KD_C\ \text{mm}.$$

where, the coefficient K shall be as given below:

Number of Cores	*Assembly Coefficient* K
(1)	(2)
2	2.00
3	2.16
4	2.42
5	2.70

b) For cables with cradle separator (cradle containing bare earth conductor or without bare earth conductor):

$$D_f = K(D_C + 1.80) - 1.8\ \text{mm}.$$

where, the coefficient K shall be as given above.

NOTE — Based on this D_f value both inner sheath and simultaneously outer sheath thicknesses shall be chosen while referring Table 3A and only inner sheath thickness shall be chosen while referring Table 3B.

E-2.5 Inner Sheath

The fictitious diameter over the inner sheath, D_B, shall be as given below:

$$D_B = D_f + 2\,t_B\ \text{mm}$$

where

t_B = thickness of inner sheath in mm.

E-2.6 Collective Protective Metallic Screen

The fictitious diameter over the collective protective screen, D shall be as given below:

$$D_s = D_B + 3.0$$

NOTE — Based on this D_s value, the outer sheath thickness shall be chosen from Table 3B.

E-2.7 Armour

The fictitious diameter over the armour, D_X, shall be given below:

$$D_X = D_B + 2t_A\ \text{mm}$$

where

t_A = diameter of stranded armour which shall be taken as 3 times diameter of individual armour wire.

NOTE — Based on this D_X value, the outer sheath thickness shall be chosen from Table 3B.

ANNEX F

(*Clause* 25.2.1)

SAMPLING OF CABLES

F-1 LOT

F-1.1 In any consignment the cables of the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

F-2 SCALE OF SAMPLING

F-2.1 Samples shall be taken and tested from each lot for ascertaining the conformity of the lot to the requirements of the specification.

F-2.2 The number of samples to be selected shall be as given below:

Number of Drums in the Lot	*Number of Drums to be Taken as Sample*	*Permissible Number of Defectives*
(1)	(2)	(3)
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 and above	20	1

F-2.2.1 These samples shall be taken at random. In order to ensure the randomness of selection, procedure given in IS 4905 may be followed.

F-3 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

F-3.1 From each of the drums selected, suitable lengths of test samples shall be taken. These test samples shall be subjected to each of the acceptance tests (*see* **25.2**). A test sample is called defective if it fails in any one of the acceptance tests. If the number of defectives is less than or equal to the corresponding permissible number given in col 3 of the table under **F-2.2**, the lot shall be declared as conforming to the requirements of acceptance tests; otherwise not.

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